FINAL REPORT

INDUSTRIAL WASTE, STREAM POLLUTION SURVEY

REDSTONE ARSENAL, ALABAMA

FEBRUARY 1966

PREPARED FOR

THE POST ENGINEER

U. S. ARMY MISSILE SUPPORT COMMAND

REDSTONE, ARSENAL

BY

U. S. CORPS OF ENGINEERS

MOBILE DISTRICT OFFICE

MOBILE, ALABAMA

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REFERENCES

REPORT, U. S. Department of Health Education And Welfare, Public Health Service, November 1963, subject: Preliminary Report, Stream Pollution, Industrial Wastes Survey, Redstone Arsenal, Alabama.

REPORT, U. S. Department of Health Education And Welfare, Public Health Service, March 1964, subject: Interim Report, Stream Pollution, Industrial Wastes Survey, Redstone Arsenal, Alabama.

CONFERENCE, U. S. Department of Health, Education And Welfare, Public Health Service, April 10, 1964, subject: Summary, Conference On Redstone Arsenal March 26, 1964, Atlanta, Georgia.

REPORT, Tennessee Valley Authority, December 4, 1964, subject: Stream Pollution Investigations, Redstone Arsenal, Huntsville, Alabama, November 16-20, 1964.

REPORT, Tennessee Valley Authority, February 26, 1965, subject: Addendum To The Report of December 4, 1964, On Stream Pollution Investigations Redstone Arsenal, Huntsville, Alabama November 16-20, 1964.

REPORT, Tennessee Valley Authority, September 22, 1965, subject: Analysis of Progress Report, Stream Pollution Program, Redstone Arsenal.

MEMORANDUM, Redstone Arsenal Post Inspector, November 1943, subject: Report Of Investigation Of Contamination Of Indian Creek During The Month of September.

REPORT, Redstone Arsenal Utilities Laboratory, September 11, 1944, subject: A survey of Domestic And Industrial Waste Deposits On Bottom of Wheeler Reservoir, Huntsville Creek And Triana As Affected By Stream Pollution.

MEMORANDUM, Redstone Arsenal Utilities Branch, June 23, 1952, subject: Contamination of Streams.

REPORT, Redstone Arsenal Utilities Branch, August 26, 1954, subject: Sanitation Survey of Huntsville Spring Creek.

REPORT, Redstone Arsenal, Utilities Laboratory Control, Undated, subject: 1963 Report Stream And Industrial Drain Analyses.

REPORT, Redstone Arsenal, Utilities Laboratory Control, Undated, subject: 1964 Report Stream And Industrial Analyses.

REPORT, Redstone Arsenal, Utilities Laboratory Control, May 6, 1965, subject: Progress Report, Stream Pollution Abatement Program, Redstone Arsenal.

PRELIMINARY REPORT

INDUSTRIAL WASTE, STREAM POLLUTION SURVEY

REDSTONE ARSENAL, ALABAMA

DECEMBER 1965

OBJECTIVE

The Post Engineer, U. S. Army Missile Support Command at Redstone Arsenal, requested the Mobile District of the U. S. Army Corps of Engineers to make a comprehensive Investigation of all facilities discharging industrial and domestic waste into the streams which traverse the Arsenal and to recommend control measures for those facilities requiring corrective action. Control measures should be conclusive and sufficient to reduce all sources of contamination contributing to stream pollution which originate from within the Arsenal, exclusive of the Marshall Space Flight Center (NASA), to within acceptable limits. A separate study of industrial waste at the Marshall Space Flight Center is being conducted by Whitman, Requardt & Associates of Baltimore, Maryland during the period of 3 October 1965 to 16 January 1966.

BACKGROUND

Stream pollution has been a problem at Redstone Arsenal for several decades. The first attempt to survey this problem on record was reported in November, 1943, by an Arsenal Toxicologist, Harry Gilman. He reported at that time that fish kills in Indian Creek were attributable to the discharge of large amounts of chemicals into the creek. It was also noted that few fish, if any, were found above the juncture of Indian Creek and Huntsville Spring Branch. It was 1952 before this problem was studied again when Niles Prestage of the Utilities Branch reported in July of that year, "Huntsville Spring Creek which received the untreated sewage from the city of Huntsville, and industrial waste from the Huntsville area is grossly polluted below the outfalls for its entire length." The outfalls referred to are the sanitary outfalls which discharged untreated waste into Spring Branch within the Huntsville metropolitan area. In May 1953, industrial plants operating on the Arsenal were cited as contributors to the industrial waste pollution of Spring Branch. These polluted conditions remained essentially unchanged during the 1952-1963 interim. The City of Huntsville constructed sewage treatment facilities during this period but the population of Huntsville expanded at such an explosive rate that the sewage treatment requirements have always been greater than the capability of their facilities. This point will be developed later in the report.

The establishment of the Marshall Space Flight Center at Redstone Arsenal created more industrial waste problems, compounding an already bad situation. The industrial waste problems of NASA are being investigated by others and will not be discussed in this report.

In August 1963 the Redstone Post Engineers sought outside help for their stream pollution problem by requesting the Atlanta Regional Office of The U. S. Public Health Service to conduct an industrial waste survey at the Arsenal. Shortly thereafter, the Congressional Subcommittee of Natural Resources and Power, Committee on Government Operations, 88th Congress, Robert E. Jones Chairman, directed the U. S. Public Health Service to review water pollution abatement practices at this installation. Consequently, the Public Health Service investigated waste practices on the Arsenal from an enforcement standpoint for the Jones Committee and not as a service to the Post Engineers. The investigation disclosed various waste disposal practices in need of remedial action. In almost all instances cited some degree of corrective action was taken. The Tennessee Valley Authority conducted a stream pollution study on the Arsenal during November 16-20, 1964, to supplement the Public Health Service study and to assess prevailing conditions after abatement measures had been initiated. It was the conclusion of TVA that Huntsville Spring Branch was still polluted with industrial and domestic waste. Conditions were again surveyed by the Army Environmental Hygiene Agency in September, 1965, however, the report on this study has just been released. *

SCOPE OF WORK

A general scope of work to be performed was set forth in the Post Engineers' Letter, SWID-EE, dated 14 June 1965, as follows:

a. Survey

(1) Make a comprehensive investigation and survey of all facilities contributing industrial wastes into the streams within Redstone Arsenal and the streams entering the arsenal.

(2) List the contributors by name and/or building number where discharge effluents are found to be detrimental and requiring corrective measures.

(3) Recommend feasible means of adequate abatement control for each facility requiring corrective action.

(4) For funding purpose, provide separate cost estimate (design excluded) on each recommended abatement action required (excluding contributions from outside the Arsenal).

b. Report

(1) Will include the purpose and the requirement for elimination of stream pollution conditions existing at Redstone Arsenal as of 1963.

* Note: This Survey verified other surveys.

(2) Corrective actions taken by MDE industrial lessees and agencies of the Army Missile Command, Redstone Arsenal.

(3) Incorporation of items of work listed under Paragraph 1a above and any other comments deemed appropriate.

(4) Reference the study being undertaken under A-E contract for Marshall Space Flight Center.

THE PURPOSE AND REQUIREMENT AS OF 1963

The purpose and requirement for elimination of stream pollution existing at Redstone was set forth in the President's Directive of December 14, 1962 to the Department of Health Education and Welfare, charging them to implement section 9 of the Federal Water Pollution Control Act (33 USC 466th).

In this letter the President wrote:

"I share your concern over the fact that we do not have fully effective programs to control water pollution at all Federal Installations. The Government should set an example in the abatement of water pollution, and I hope the deficiences noted in your report (WASTE WATER DISPOSAL PRACTICES AT FEDERAL INSTALLATIONS, a series of 58 reports) will be corrected at the earliest possible time."

THE AREA

Figure II is a generalized map of the Redstone Arsenal Reservation. The scope of this study covers facilities which discharge waste into Huntsville Spring Branch. The Architect-Engineer for NASA is studying the facilities which discharge waste into Indian Creek. Huntsville Spring Branch flows southwardly from the City of Huntsville and crosses from east to west, the southern half of the reservation where it joins Indian Creek approximately 5.5 miles above the Tennessee River into which it then empties.

INVESTIGATIONAL PROCEDURE

On-site inspection and plant interviews were conducted from 23 July through 30 July 1965, of all facilities which discharge liquid waste to determine quantities and constituents of the waste. It was also the purpose of this investigation to review the abatement measures that had been initiated by the industries cited by the U. S. Public Health in 1963 as major contributors to the pollution of Huntsville Spring Branch. After completion of this phase of the study a sampling program was formulated with the aid of the Post Engineer's Utilities Division to evaluate the adequacy of the present industrial waste treatment facilities and to assess the prevailing conditions. The intensity of the sampling program was governed by the fact that the investigators have been working closely with the problem since the first survey in 1963 and have had the advantage of several previous studies.

Some of the sampling stations were selected to correspond to those in previous studies, thereby allowing a comparison; others were selected for control and additional check points. Descriptions and designations of these points are given in Table I and are shown on the map in Figure II. The Post Engineer Utilities Division collected samples at these stations during September 1965, and performed all analyses except those for the chlorinated hydrocarbons. These latter analyses were performed by the U.S.P.H.S., Robert A. Taft Engineering Center, Cincinnati, Ohio. The center had a backlog of work when the samples were received and it was mid November, 1965 before the results became available.

WASTE SOURCES

INDUSTRIAL

Amoung those facilities surveyed were:

- Olin Mathieson Chemical Corporation.
- Stauffer Chemical Plant No. 2
- Wittichen Chemical Company
- General Aniline And Film Corporation
- Thiokol Facilities
- Rhom And Haas
- AMC, Research And Development Directorate
- Sewage Treatment Plants 1, 3 and 4
- City of Huntsville Sewage Treatment Plant

OLIN MATHIESON CHEMICAL CORPORATION

This plant produces from 1.5 to 2.0 million pounds of DDT insecticide each month on a continuous operating schedule. A solution of DDT is produced by combining mono-chlorobenzene with chloral in a batching operation. After the DDT solution is washed three times, once with water once with a caustic solution then a second time with water, it is solidified, ground and bagged. Chloral production is an intermediary step in the process accomplished by reacting chlorine with acetaldehyde which forms hyclrochloric acid as a waste product. Sulfonic acids are formed when chloral is dried with sulfuric acid; the sulfonic acid and unspent sulfuric acid are passed through a crushed limestone neutralizing bed before they are discharged into a waste ditch. This plant discharges approximately 1.5 MGD of waste water containing DDT from the washing process, mono-chlorobenzene, chloral, sulfuric and sulfonic acids into the 5000 area waste ditch.

In order to correct the deficiencies pointed out during the 1963 U.S.P.H.S. survey, Olin constructed a 7550 gallon settling tank to remove DDT from the final plant effluent and purchased a continuous sampler and a gas chromatograph. The chromatograph as of the date of this investigation has never operated properly and the DDT settling tank was filled to the overflow with solids. The tank had been emptied once since it was placed into operation and appears to function satisfactorily if the DDT solids are removed as required.

STAUFFER CHEMICAL COMPANY, PLANT NO. 2

The Stauffer Chemical Company operates two caustic chlorine plants on the Arsenal, each an exact duplicate of the other and each produces 50 tons of chlorine and 56 tons of sodium hydroxide solution per day. This study covers only plant No. 2 which is located in the 5000 area.

Chlorine and sodium hydroxide are produced by the electrolysis of sodium chloride brine. The basic raw material, sodium chloride, is treated with sodium carbonate to remove the calcium and magnesium impurities which produces approximately 500 lbs/day of solid waste. The chlorine is stripped from the water with steam and the sodium hydroxide is concentrated in vacuum evaporators. The plant discharges approximately 3.5 MGD of waste water which combines with the effluent from General Aniline and Film Corporation before emptying into the 5000 area waste ditch downstream of the DDT plant.

As a result of the U.S.P.H.S. investigation in 1963, the Stauffer Company took remedial action by constructing a sedimentation basin for the removal of chloride and magnesium solid wastes and two recovery tanks to collect a 15% sodium hypochlorite solution. The effluent from the sedimentation basin discharges through a marsh area into

Huntsville Spring Branch and the waste from the recovery tanks is allowed to discharge at about 2 GPM into the industrial waste ditch. The chlorine cooling tower discharges waste water having a temperature of 210° F., and containing a minimum of 400 mg/l of chlorine from an incomplete stripping process into the 5000 area waste ditch along with spent cooling water from the ammonia condensers and the refrigeration units.

THE WITTICHEN CHEMICAL COMPANY

The Wittichen Company produces approximately 5000 gallons per week of laundry bleach, 15% sodium hypochlorite, in 2500 gallon batches by introducing liquid chlorine into a tank of sodium hydroxide solution. This process consumes 50 tons per week of chlorine, obtained from the Stauffer's No. 2 Plant by direct pipe connection, and 5000 gallons per week of potable water. The waste water, washings from the batch tanks and chlorine cylinders, amounts to about 100 GPD and is allowed to discharge into the sedimentation ditch used by Stauffer for the removal of carbonate impurities.

GENERAL ANILINE AND FILM CORPORATION

This corporation produces 50,000 lbs per month of purified iron (Pentacarbonyl) by pelletizing crude sponge iron and then reducing it with hydrogen. The iron is then heated to yield a purified iron powder. Two waste streams leave the plant: one stream comes from the carbon monoxide gas scrubber, which is a flow ranging from 200 GPH to 500 GPH containing traces of ammonia, and the other waste stream is one-pass cooling water, a flow of approximately 30,000 GPO. The waste stream from the scrubber discharges into a marshy area draining into Huntsville Spring Branch. The cooling water passes through four settling tanks before it is released into the 5000 area industrial waste ditch.

ROHM AND HAAS

Rohm and Haas develop and conduct research on propellants at the Arsenal. The wastes from this operation are varied and occur usually in small quantities. Because of the nature of the operation, waste disposal is well controlled. There is no water used in the process; the only water wasted comes from washing the floors and equipment. This water flows through sand filters in the floor sumps, where solids are removed before the water is emptied into drainage ditches. All solvents and solid wastes are routinely collected in hazardous waste containers and desensitized before disposal.

THIOKOL

The Thiokol Company also develops and conducts research on propellants and the wastes are much the same as that of Rohm and Haas. The explosive materials are taken to the Redstone demolition area for burning and disposal. Sump pits are used to collect the solid materials from the wash water in the floor drains after which this water is transported by drainage ditches to a swamp area that drains into Huntsville Spring Branch. The disposal of all waste materials from this operation is well controlled.

RESEARCH AND DEVELOPMENT DIRECTORATE, AMC

This directorate operates numerous shops and laboratories on the Arsenal. The liquid wastes from these buildings are test-tube quantities and have caused no known problems.

The waste from the developing process at the RCA Photo and Video Laboratory, Building 4489, discharges about 30 GPD to the sanitary sewage collection system that serves treatment Plant No. 3. A toxic compound of potassium and cyanide is contained in this effluent in concentrations of 30 mg/l but apparently causes no difficulty at the sewage treatment plant.

SOURCES OF WASTE

Domestic

The domestic sewage on the Arsenal is treated by three trickling filter plants, eleven aerobic digestion plants, one Imhoff system and many septic tanks. The three major plants are well operated and are performing satisfactorily. Sample data collected from the trickling filter plants are shown in Table VIII.

TREATMENT PLANT NO. 1. This plant, located in the 7000 area, has a rated capacity of 325,000 GPD. The flows recorded during the sampling period ranged from 500,000 GPD to 140,000 GPD. Even when the plant was hydraulically overloaded at 500,000 GPD, the B.O.D. reduction was 89% efficient. The data also indicate that suspended solids are satisfactorily removed.

TREATMENT PLANT NO. 3. This plant, which is located in the 4000 area and serves the NASA complex, has a rated capacity of 600,000 GPD. The flows at the time of sampling ranged from 1,775,000 GPD to 2,000,000 GPD. The minimum effiency of B.O.D. removal was 80.7%. Suspended material was effectively removed. This plant, though hydraulically overloaded, does a satisfactory job of reducing the B.O.D. and removing settleable solids.

TREATMENT PLANT NO. 4. This plant, located in the 3000 area, has a rated capacity of 813,000 GPD. The data collected shows that the plant performs well yielding a minimum B.O.D. reduction of 90.2% and effective removal of suspended solids. Difficulty in operation of the primary settling tank is experienced at this plant because of the poor inlet features. Water stands in the inlet channel at all times causing the channel to function as a settling tank. The buildup of solids in the channel requires continual cleaning.

IMHOFF TANK AND PACKAGE PLANTS. Records are not available to indicate the efficiency of the aerobic digestion plants, the septic tanks or the Imhoff tank. There have been no reported problems with these systems and all appear to function satisfactorily.

THE CITY OF HUNTSVILLE SEWAGE TREATMENT PLANTS. The city of Huntsville has a 10 MGD activated sludge sewage treatment plant located on South Memorial Parkway and discharges its effluent into Huntsville Spring Branch approximately one half mile before the stream enters the Arsenal reservation. The present average daily flow through this plant is 17-20 MGD but during periods of heavy rainfall flows of 30-40 MGD have been experienced. Even at average flows the plant is at least 70% overloaded and at peak flows most of the untreated sewage must be by-passed.

The City has under construction a 2.5 MGD plant approximately one mile above the Tennessee River along Aldridge Creek in the Whitesburg Community. Operations should begin at this plant early in 1966 but it will receive only a small portion of the flow (an estimated 100,000 GPD) now going to the main plant and relief to the main plant will be negligible.

Now in this conceptual design stage is a 20 MGD expansion to the main treatment plant which the City anticipates having operative within the next three or four years.

STREAM DATA - HUNTSVILLE SPRING BRANCH. Sampling stations were established along the route of Huntsville Spring Branch so that conditions of the stream could be checked at a point upstream of the Huntsville Sewage Treatment Plant, at the point of effluent discharge of the plant, immediately after it entered the reservation and at critical points along its course within the Arsenal.

The Hunstville Spring Branch, before it reaches the Huntsville sewage treatment plant is high in D.O., averaging above 11 PPM for the samples collected, and low in 5-day, 20° C Biochemical Oxygen Demand (BOD). The maximum observed BOD is 3.5 PPM. Measurements were not made of the flow in this stream but it is known to be small when compared to the treatment plant effluent and therefore provides very little, if any, dilution or assimilative capacity. Effluent from this plant contributes the major flow in the stream at this point and as it enters the reservation. B.O.D. exertion is evident at the Huntsville Treatment Plant and increases progressively until the D.O. is zero at Station 5.7, Spring Branch and Patton Road (shown in Table II). Coliform counts were 110,000 + MPN/100 ml in the stream as it entered the Arsenal (shown in Table IV). The stream continues to be grossly polluted with organic material as it enters the Arsenal.

Analyses of samples collected in the stream, station 5.7, after it received the effluent from the city of Huntsville and Arsenal Treatment Plants one and four, demonstrated a B.O.D. of approximately 29 PPM and a D.O. of zero. A D.O. of 1.5 PPM and an average B.O.D. of 17.5 for the samples collected were observed at station H 4.7 which indicated that the exertion of the B.O.D. was nearly complete at this point.

Analyses of samples collected at station H4.7, about 0.2 miles downstream from the point of waste discharge from the 5000 industrial area were not sufficient in number to reveal the wide fluctuation of parameters at this station. However, observations made at station WD (shown in Table III) throughout the year indicate the trends of the constituents in the 5000 area waste ditch. The pH varies from 1.8 to 10.5 for the combined industrial plant discharges. Dissolved solids varied greatly, from 222 to 6200 ppm. Chlorine varied from zero to 10.3 PPM. Chlorides in the 5000 area were checked only at the Stauffer No. 2 plant for three different periods during the 1965 calendar year. The maximum chloride concentration for the samples collected was 545 PPM (Data not contained in this report). Chloride concentrations varied at station H 4.7 from 48.0 PPM to 227.5 PPM for the samples collected (shown in Table II). Chemical oxygen demand (COD) of the stream in the vicinity of the 5000 industrial outfall increased from station H 5.7 to station I 4.6, as might have been anticipated.

Analyses for DDT, DDD and DDE concentrations were performed in both water and bottom mud samples (sample data are shown in Tables VI and VII). Quantities of DDT in the Olin Mathieson Effluent varied from 1,787 PPB to 16,258 PPB for the samples collected. DDT concentrations varied at H 4.7, just below the industrial waste ditch outfall, from 83.6 PPB to 110.3 PPB; below the juncture of Indian Creek and Huntsville Spring Branch, I 4.6, concentrations varied from 0.5 PPB to 1.3 PPB. Analyses of bottom mud samples indicated substantial deposits of DDT in the bottom of the industrial waste ditch and the bed of Huntsville Spring Branch. The quantities of DDT in the mud samples diminish as the distance from the source increases with concentrations ranging from 2,236 PPM at station WM to 9.26 PPM at station I4.6.

GUIDELINE STANDARDS

To assist in the control of waste disposal and stream pollution at Redstone Arsenal, the Tennessee Valley Authority proposed guidelines for limiting maximum concentrations of materials injurious to public health or to fish and wildlife. These standards were presented to the Post Engineer at Redstone Arsenal in September 1965, with the concurrence of the Executive Secretary of the Alabama Water Improvement Commission and the Regional Program Director, Water Supply And Pollution Control, Region IV, Public Health Service. These following tentative guidelines apply to the waters of Huntsville Spring Branch and Indian Creek after they have mixed with Redstone Arsenal waste;

DDT	Not more than 10 parts per billion
pH	Between 6.5 and 8.5 except that pH may exceed 8.5 when due to photosynthetic effects
Chlorine	Not more than 0.3 part per million
Chlorides	Not more than 500 parts per million
Dissolved Oxygen	Not less than 4.0 parts per million
Cyanide	Not more than 0.025 part per million
Monochlorobenzene	Not more than 3.0 parts per million
Other wastes	None singly or in combination with others in such concentrations or at such temperatures as to be injurious to the public health or to fish or wildlife

TVA made the following stipulations to these proposed guidelines:

1. These are only guidelines, or tentative standards, and will be subject to change as new information indicates the need.

2. These guidelines will apply only as long as the present water uses are in effect. Future changes in the water uses, such as municipal water supply, may require revisions.

CONCLUSIONS

1. **Huntsville Spring Branch.** This stream continues to be grossly polluted as it enters the Arsenal in a condition devoid of oxygen and high in organic matter. No immediate relief is anticipated for this condition as it is contingent upon the City of Huntsville providing sufficient sewage treatment. City officials relate that efforts are now underway to provide adequate treatment but this, at best, will be no sooner than three years away. More realistically, it will be five years before adequate treatment facilities could be placed into operation.

2. **Olin Mathieson Chemical Company.** This plant continues to discharge toxic pH and toxic concentrations of DDT. Chlorine in the waste discharge does not appear to be a problem any longer. The sedimentation tank, designed for DDT removal and placed into operation in January 1965, has not been satisfactorily maintained and operated. Although the solids have been removed from the tank on two occasions, the tank was observed to be filled to the overflow with solids during this survey. The gas chromatography equipment purchased by Olin for measurement of DDT in minute concentration has not functioned properly since it was obtained. Acid spillages in the plant area have not been adequately controlled. DDT deposits removed from the bottom of the industrial waste ditch were spoiled along the banks of the ditch in the proximity of the plant.

3. **Stauffer No. 2 Plant.** The settling ditches dug by Stauffer to remove carbonate wastes appear to function well but need cleaning. Chlorine contained in the effluent appears to dissipate in the open channel before the point is reached where the Stauffer and Olin wastes enter the channel. Toxic pH and a wide fluctuation of dissolved solids continue to characterize the plant effluent.

4. General Aniline And Film Corporation. The waste effluent of this plant contains no appreciable pollution.

5. The Wittchen Chemical Company. There is no continuous discharge of waste from this plant; the small amount of cylinder and tank wash water that is wasted does not contribute to the pollution problem.

6. Thiokol Facilities And The Rohm And Haas Company. Waste disposal practices at these plants are adequately controlled at this time.

7. Sewage treatment plants one, three and four are providing adequate treatment. Difficult operations of the primary clarifier are experienced at number four plant but this appears to be only a nuisance factor as B.O.D. and suspended solids reduction are satisfactory. The final effluent is not chlorinated at any of these plants.

8. DDT Deposits. There are substantial deposits of DDT solids along the bottom of the 5000 area industrial waste ditch and in the bed of Wheeler Reservoir.

9. The minimum dissolved oxygen concentration of 4.0 PPM proposed by TVA cannot be obtained in Spring Branch until the City of Huntsville provides adequate sewage treatment.

10. The methods and frequency of the Sampling Program by the Utilities Division are insufficient to provide adequate surveillance over the streams on the Arsenal.

11. Regulatory Agencies have not provided sufficient guidance or direction to the personnel involved in the administration of the pollution abatement program at the Arsenal. There have been no specified guidelines until the TVA proposed tentative Standards in September 1965.

12. Waste Disposal Practices of the industrial tenants in the

5000 area have not been adequately controlled by the Government.

RECOMMENDATIONS

1. The guideline standards proposed by TVA should be enforced to the fullest extent practicable from within the Arsenal Reservation. Consideration should be given to the fact that Huntsville Spring Branch is organically polluted when it enters the Reservation.

2. The responsibility for the surveillance of pollution abatement on the Arsenal should be clearly defined. The organization which is assigned this responsibility should establish a regular program of sampling and on-site investigations for positive control. The sampling program should include continuous sampling monitor stations with recording heads located at critical points along Huntsville Spring Branch, such as at H 4.7 and I 4.6.

3. It is recommended that a new waste ditch be excavated in the 5000 area but only after assurance has been given that the discharge from the DDT plant will not contaminate the new ditch.

4. The Mobile District Office, U. S. Corps of Engineers should require its industrial tenants in the 5000 area to take the measures required to reduce industrial contaminates to within acceptable limits.

5. Indications are that resuspension from the DDT bottom deposits of Wheeler Reservoir will be in concentrations less than the proposed maximum upper limit of 10 PPB. Any attempt to remove bottom deposits from Wheeler Reservoir or to rechannel Huntsville Spring Branch will create a worse condition than now exists. However, as soon as funds become available deposits on the bottom of Huntsville Spring Branch should be investigated with a comprehensive core-boring program to determine the extent of contamination in depth and coverage.

6. After the City of Huntsville ceases to pollute Spring Branch, the final effluent from the major sewage treatment plants on the Arsenal should be chlorinated.

TABLE I

SAMPLE STATIONS

Sample Station*	Location	Corresponding Sample Station of Previous Studies	
		PHS Sept. 1963	TVA Dec. 1964
H 11.73	Huntsville Spring Branch at Johnson Road		
H 10.40	City of Huntsville Sewage Treatment Plant Effluent		
H 9.45	Huntsville Spring Branch at Martin Road	H 9.45	
M 1.25	McDonald Creek at Martin Road	M 1.25	
H 7.45	Confluence of McDonald Creek & Huntsville Spring Branch	H 7.45	
H 5.75	Huntsville Spring Branch at Patton Road	H 5.7	STA 1
H 4.7	Huntsville Spring Branch Downstream of Waste Ditch	H 4.7	STA 2
H 2.55	Huntsville Spring Branch at Dodd Road	H 2.55	STA 3
I 4.6	Indian Creek at Firing Range Bridge	I 4.66	STA 7
5000 Area Waste Ditch			
WO	Olin Mathieson Effluent		
WS	Stauffer No. 2 Effluent		
WD	Waste Ditch Flow Just Before Discharge Into Huntsville Spring Branch		
WU	Bottom Sample of Waste Ditch, Upper End		
WM	Bottom Sample of Waste Ditch, Middle		
WL	Bottom Sample of Waste Ditch, Lower End		
4000 Area			
SNI	Stauffer Plant No. 1, Industrial Sewer Manhole		

* Estimated river miles above mouth of stream.

H = Huntsville Spring Branch
M = McDonald Creek
I = Indian Creek

TABLE II

STREAM SAMPLES

SAMPLE STATION	DATE 1965	TIME CST	TEMP °C	pH	ACIDITY OR ALKALINITY PPM	DISLVD SOLIDS PPM	D.O. PPM	O_2 % SAT	B.O.D. PPM	CHLORINE PPM	CHLORIDE PPM
H 11.73	9-8	1055	29	8.4		120	15.1	195	2.6		
	9-9	1005	26	8.0		103	11.2	136	3.5		
	9-10	0900	26	8.4		137	11.4	139	2.6		
H 10.40	9-8	1115	27	7.6		240	2.4	29.6	65+		
	9-9	1035	27	7.4		308	2.0	24.7	66+		
	9-10	0935	27	7.4		359	2.5	30.9	68.8		
H 9.45	9-8	1135	29	7.4		240	1.8	23.1	27.1		
	9-9	1055	28	7.3		226	3.2	40.5	19.5		
	9-10	0955	27	7.3		240	2.4	30.4	14.3		
	11-15	0935	17	7.3	Bicarb 173	205				0.0	31.0
	11-16	0920	17	7.4	Bicarb 190					0.0	40.0
	11-17	0920	13	7.2	Bicarb 188	240	4.1				36.5
M 1.25	9-8	1145	23	7.3		137	4.2	48.3	3.6		
	9-9	1105	20	7.3		120	3.5	38.0	4.9		
	9-10	1015	24	7.3		120	3.5	41.2	3.8		

See TABLE IX for Flows

Analyses by Redstone Utilities Division on Single Grab Samples

TABLE II - Cont'd

STEAM SAMPLES

SAMPLE STATION	DATE 1965	TIME CST	TEMP °C	pH	ACIDITY OR ALKALINITY PPM	DISLVD SOLIDS PPM	D.O. PPM	O_2 % SAT	B.O.D. PPM	CHLORINE PPM	CHLORIDE PPM
H 7.45	9-8	1035	27	7.4		154	0.2	2.5	30.8		
	9-9	1125	25	7.3		240	0.0	0.0	18.5		
	9-10	1030	27	7.2		256	0.0	0.0	35.2		
H 5.7	9-8	0915	25	7.5		171	0.0	0.0	28.9	0.0	
	9-9	0820	25	7.3		240	0.0	0.0	19.6	0.0	
	9-10	0800	26	7.3		240	0.0	0.0	18.4	0.0	
	9-22	0815									33.0
	9-23	0815									26.5
	11-15	0925	17	7.3	Bicarb 182	188				0.0	36.5
	11-16	0910	17	7.4	Bicarb 180		0.0	0.0		0.0	34.0
	11-17	0910	15	7.1	Bicarb 193	240					37.5
H 4.7	9-8	1000	28	7.6		171	1.3	16.5	14.8	0.0	
	9-9	0835	26	5.5		240	0.8	9.8	13.5	0.0	
	9-10	1050	28	6.8		240	1.5	19.0	17.6	0.0	
	9-22	0925									145.0
	9-23	1035									48.0
	11-15	0945	19	3.1	Acidity 53	769				0.0	213.5
	11-16	0935	20	7.5	Bicarb 156					0.0	197.0
	11-17	0945	18	7.4	Bicarb 191	550				0.0	227.5

See Table IX for Flows

Analyses by Redstone Utilities Division on Single Grab Samples

TABLE II - Cont'd

STEAM SAMPLES

SAMPLE STATION	DATE 1965	TIME CST	TEMP °C	pH	ACIDITY OR ALKALINITY PPM	DISLVD SOLIDS PPM	D.O. PPM	O_2 % SAT	B.O.D. PPM	CHLORINE PPM	CHLORIDE PPM
H 2.55	9-8	0825	26	7.5		205	0.9	11.0	18.0		
	9-9	0910	25	7.3		273	1.2	14.3	20.0		
	9-10	0815	26	6.9		240	1.2	14.6	14.5		
	11-15	0835	17	7.2	Bicarb 163	291				0.0	51.5
	11-16	0835	18	7.5	Bicarb 157		2.1	22.0		0.0	68.5
	11-17	0830	15	7.1	Bicarb 156	300	2.0	19.7			78.0
I 4.6	9-8	0850	27	7.6		171	3.6	44.4	7.3		
	9-9	0925	27	7.5		240	3.4	42.0	5.7		
	9-10	0825	26	7.4		205	2.6	31.7	6.0		
	9-22	0900									44.0
	9-23	0950									47.5
	11-15	0905	16	7.5	Bicarb 137	273				0.0	56.5
	11-16	0845	16	7.5	Bicarb 132					0.0	65.5
	11-17	0845	15	7.3	Bicarb 133	275					72.0

See TABLE IX for Flows

Analyses by Redstone Utilities Division on Single Grab Samples

TABLE III

5000 AREA INDUSTRIAL WASTE SAMPLES

SAMPLE STATION WO — OLIN MATHIESON EFFLUENT

Date 1985	Time CST	Temp °C	ph	Hydrx Alky mg/l	Min. Acid mg/l	Dislvd Solids mg/l	Cl_2 mg/l	Flow[3] MGD
9-14	1205	34	2.9	0.0	146	1300	0.00	1.58
9-22	1000	34	2.8	0.0	110	650	0.00	
9-23	1110	34	3.5	0.0	50	699	0.00	

SAMPLE STATION WS — STAUFFER NO. 2 EFFLUENT

Date 1985	Time CST	Temp °C	ph	Hydrx Alky mg/l	Min. Acid mg/l	Dislvd Solids mg/l	Cl_2 mg/l	Flow[3] MGD
9-14	1210		7.4	0.0	0.0	171	13.0	3.73
9-22	1005	38	7.1	0.0	0.0	188	5.5	
9-23	1110	34	6.8	0.0	0.0	188	10.9	

SAMPLE STATION WD — WASTE DITCH BEFORE DISCHARGE INTO SPRING BRANCH

Date 1985	Time CST	Temp °C	ph	Hydrx Alky mg/l	Min. Acid mg/l	Dislvd Solids mg/l	Cl_2 mg/l	Flow[3] MGD
9-14	1130		4.0	0.0	25.0	700	0.00	5.5
9-22	0940	37	6.3	0.0	0.0	511	0.02	
9-23	1045	33	6.7	0.0	0.0	445	0.00	

OTHER SAMPLES BY REDSTONE[2]

STATION 1

Date	Time	Temp	ph	Hydrx Alky	Min. Acid	Dislvd Solids	Cl_2	Flow
1-5	1110	16	8.4	0.0	0.0	154	0.0	0.85
2-19	1305	21	2.9	0.0			0.0	0.83
3-11	1045	20	2.8	0.0	87.0	769	0.0	0.68
4-7	1010	29	1.6	0.0	1200	5300	0.0	0.75
4-12	1435	28	2.2	0.0	412	1300	0.02	
4-14	0915	25	2.3	0.0	64	700	0.0	
4-14	1000	28	2.6	0.0		718	0.0	
4-15	0855	26	2.4	0.0	65	735	0.0	
4-16	1000	26	2.5	0.0	69	750	0.0	
4-20	1010	30	3.0	0.0		780	0.02	
4-21	0930	30	3.1	0.0		1090	0.0	
4-22	1445	32	3.4	0.0		750	0.0	
4-23	0920	29	2.6	0.0	120	855	0.06	
5-10	1530	36	3.5	0.0		900	0.0	1.13
5-11	1020	30	3.4	0.0		445	0.0	
5-13		31	2.9	0.0	116	1026	0.0	
5-18	0925	33	2.9	0.0	69	547	0.0	
5-19			4.0	0.0		325	0.0	
5-25	1100	34	2.2	0.0	266	1690	0.0	
6-2	0960	34	4.1	0.0	7	410	0.0	1.52
6-10	1045		7.4	0.0	0	1620	0.0	
6-15	1110	30	2.9	0.0		760	0.02	
6-17	1000	32	1.3	0.0	1020	11970	0.0	
6-21	1500		2.6	0.0		940	0.0	
6-22	1200	35	3.6	0.0		359	0.0	
6-24	0935	35	3.3	0.0	30	376	0.0	
6-29	1010	36	3.1	0.0	25	342	0.0	
7-1	1040	34	3.9	0.0	14	325	0.0	1.92
7-7	0940	34	3.2	0.0		376	0.02	
7-9	1350	35	4.0	0.0	30	479	0.0	
7-13	1015	34	3.0	0.0		511	0.0	
7-20	1127	37	3.5	0.0	42	445	0.0	
7-22		37	3.7	0.0	32	445	0.01	
7-27	0955	35	2.6	0.0	342	90	0.0	
7-29	1052		3.2	0.0	58	650	0.0	
8-3	1345		2.6	0.0	270	1539	0.0	1.23
8-5	1020	34	1.7	0.0	1950	6500	0.01	
8-10	0935	36	3.5	0.0	5	1368		
8-26	0930	34	3.8	0.0	15	511	0.0	
10-4	0950	28	8.6	0.0	17	700	0.0	1.29
10-5	1020	22	8.0	0.0	0	120	0.0	
10-6	1025	25	1.6	0.0	504	7000	0.0	
10-7	0915	25	6.3	0.0	0	1050	0.0	
10-8	1055	34	2.0	0.0		1197	0.0	
10-12	0930	23	2.4	0.0	407	2394	0.02	
10-22	0930	24	2.0	0.0	1160	3420	0.0	
10-26	0925	25	6.4	0.0	0	291	0.0	
10-28	1055	25	5.2	0.0	0	1539	0.0	
11-2	0947		2.8	0.0	165	699	0.0	

STATION 2

Date	Time	Temp	ph	Hydrx Alky	Min. Acid	Dislvd Solids	Cl_2	Flow
1-5	1110	21	8.2	0.0	0.0	342	3.8	2.70*
2-19	1305	32	9.5		0.0		4.7	2.43
3-11	1045	25	7.5	0.0	0.0	410	3.8	2.64
4-7	1010	19	7.8	0.0	0.0	718	5.2	2.81
4-12	1435	34	7.2	0.0	0.0	256	1.9	
4-13	0918	33	9.6	0.0	0.0	500		
4-14	1005	35	6.6	0.0	0.0	393	3.6	
4-15	0900	28	6.5	0.0	0.0	325	4.2	
4-16	1005	31	7.7	0.0	0.0	1000	3.5	
4-16	1500	33	7.2	0.0	0.0	188	3.5	
4-20	1010	36	6.5	0.0	0.0	600	2.8	
4-21	0935	32	8.2	0.0	0.0	490	3.0	
4-22	1445	36	7.5	0.0	0.0	511	3.9	
4-23	0920	36	6.9	0.0	0.0	479	1.7	
5-10	1530	36	7.1	0.0	0.0	376	5.0	3.66
5-11	1020	26	7.4	0.0	0.0	410	5.7	
5-13		35	9.3	0.0	0.0	256	2.1	
5-18	0920	36	10.8	35.0	0.0	1400	2.9	
5-19			9.3		0.0	725	3.5	
5-25	1100	40	7.7	0.0	0.0	315	1.9	
6-2	0955	36	8.2	0.0	0.0	376	2.2	3.77
6-10	1045		11.2	111.0	0.0	2360	5.6	
6-15	1110	32	7.7	0.0	0.0	2000	12.3	
6-17	1000	36	2.6	0.0	116.0	1750	0.0	
6-21	1500		3.6	0.0		410	0.0	
6-22	1200	39	7.5	0.0	0.0	445	2.0	
6-24	0950	38	10.0	0.0	0.0	445	2.0	
6-29	1010	41	7.6	0.0	0.0	769	6.4	
7-1	1040	40	10.0		0.0	550	2.0	4.38
7-7	0940	33	6.7	0.0	0.0	699	12.0	
7-9	1350	39	9.2	0.0	0.0	376	2.6	
7-13	1015	37	7.1	0.0	0.0	342	5.4	
7-20	1125	41	9.0	0.0	0.0	479	2.10	
7-22		42	7.8	0.0	0.0	342	2.75	
7-27	0957	41	10.8	115.0	0.0	1700	2.80	
7-29	1050		9.4	0.0	0.0	1250	20.20	
8-3	1347		7.6	0.0	0.0	600	1.00	4.21
8-5	1025	35	8.0	0.0	0.0	376	1.30	
8-10	0930	40	9.0	0.0	0.0	1881	10.50	
8-26	0930	35	8.7	0.0	0.0	684	8.80	
10-4	0945	36	10.0	0.0	0.0	1250	3.0	3.75
10-5	1022	34	9.2	0.0	0.0	205	2.3	
10-6	1027	34	8.8	0.0	0.0	540	3.1	
10-7	0920	33	9.7	0.0	0.0	540	4.9	
10-8	1058	25	8.6	0.0	0.0		4.4	
10-12	0925	33	8.7	0.0	0.0	188	6.0	
10-22	0930	34	9.0	0.0	0.0	445	3.2	
10-26	0930	33	10.7	51.0	0.0	1478	15.0	
10-28	1057	22	7.8	0.0	0.0	1265	19.8	
11-2	0950		9.7	0.0	0.0	1368	18.6	

STATION 3

Date	Time	Temp	ph	Hydrx Alky	Min. Acid	Dislvd Solids	Cl_2	Flow
1-5	1110	26	8.1	0.0	0.0	291	1.20	
2-19	1305	29	6.5	0.0	0.0		0.05	
3-11	1045	24	6.4	0.0	0.0	495	0.40	
4-7	1010	21	2.7	0.0	105.0	160		
4-13	0925	31	7.9	0.0	0.0	410	0.10	
4-14	1000	32	8.0	0.0	0.0	428	0.50	
4-15	0910	28	5.4	0.0	0.0	325	0.14	
4-16	1500	33	4.4	0.0	0.0	250	0.05	
4-20	1015	34	6.3	0.0	0.0	600	0.67	
4-21	0940	31	5.9	0.0	0.0	570	0.03	
4-22		34	6.7	0.0	0.0	320	0.15	
4-22	1445	34	6.0	0.0	0.0	699	0.14	
4-23	0925	34	5.9	0.0	0.0	511	0.06	
4-29	1430	33	8.0	0.0	0.0	359	0.40	
5-10	1530	36	4.7	0.0	0.0	560	0.02	
5-11	1015	28	6.4	0.0	0.0	376	0.80	
5-13		33	4.5	0.0	0.0	410	0.00	
5-18	0920	36	6.3	0.0	0.0	410	0.08	
5-19			7.8	0.0	0.0	600	0.32	
5-25	1100	37	2.5	0.0	105.0	970	0.02	
6-2	0950	34	6.2	0.0	0.0	376	0.00	
6-10	1045		10.5	26.0	0.0	1870	0.90	
6-15	1110	31	6.6	0.0	0.0	1540	4.50	NO RECORD
6-17	1005	35	1.8	0.0	195.0	6200	0.00	
6-21	1500		3.6	0.0		479	0.00	
6-22	1200	37	6.5	0.0	0.0	410	0.00	
6-24	0940	38	9.0	0.0	0.0	495	0.60	
6-29	1015	39	6.7	0.0	0.0	699	1.70	
7-1	1040	38	9.1	0.0	0.0	359	0.01	
7-9	1350	37	6.4	0.0	0.0	376	0.01	
7-13	1015	38	4.7	0.0	0.0	325	0.00	
7-20	1125	40	6.8	0.0	0.0	428	0.00	
7-22		40	7.0	0.0	0.0	376	0.02	
7-27	1000	39	3.2	0.0	57.0	1700	0.00	
7-29	1055		4.1	0.0	0.1	700	0.00	
8-3	1350		2.6	0.0	170.0	2000	0.00	
8-5	1030	36	2.0	0.0	750.0	2900	0.00	
8-10	0940		7.1	0.0	0.0	1539	2.50	
8-26	0935	35	4.6	0.0	0.0	511	0.02	
10-4	0950	34	9.6	0.0	0.0	700	1.60	
10-5	1025	32	9.2	0.0	0.0	222	1.80	
10-6	1030	32	1.9	0.0	125.0	6846	0.10	
10-7	0920	32	9.0	0.0	0.0	850	1.10	
10-8	1104	34	6.2	0.0	0.0	470	1.60	
10-12	0930	32	3.5	0.0		325	2.70	
10-22	0935	32	4.3	0.0	0.0	479	1.60	
10-26	0930	31	9.8	0.0	0.0		10.3	
10-28	1100	22	7.0	0.0	0.0	1539	7.1	
11-2	0950		9.0	0.0	0.0	1881	7.5	

[1]Analyses by Redstone Utilities Division on single grab samples.
[2]See Figure II for sample locations.
[3]Flows are estimated on the bases of water consumption, using the daily average over the month indicated.

*Flows based on General Aniline & Stauffer No. 2 combined water consumption.

TABLE III

TABLE IV

COLIFORM COUNT

MPN/100ML

DATE 1965	H 9.45	H 4.7	I 4.6
9-8	110,000+	110,000+	11,000+
9-9	110,000+	110,000+	11,000+
9-10	110,000+	110,000+	11,000+

TABLE V

CHEMICAL OXYGEN DEMAND

(COD-PPM)

DATE 1965	H 5.7	H 4.7	I 4.6
9-21	51.5	71.4	27.7
9-22	45.9	51.8	21.6
9-23	40.3	57.0	16.8

Analyses by Redstone Utilities Division

TABLE VI

DDT, DDD AND DDE

CONCENTRATIONS IN WATER SAMPLES

WASTE DITCH

SAMPLE STATION	DATE 1965	DDT ug/l	DDD ug/l	DDE ug/l	FLOW MGD
WO	9-21	16,258.155	Masked	338.294	1.58 *
	9-22	1,786.598	50.443	118.788	1.58 *
	9-23	8,935.293	0.000	702.224	1.58 *
WD	9-21	793.904	17.797	31.163	
	9-22	124.111	2.979	4.193	
	9-23	66.344	2.513	11.626	
STREAM					
H 5.7	9-8	3.344	Masked	0.117	
H 4.7	9-8	83.601	1.916	1.870	
	9-9	27.961	0.974	1.084	
	9-10	110.320	3.001	2.903	
I 4.6	9-8	1.300	2.505	0.532	
	9-9	0.546	3.096	0.831	
	9-10	0.524	1.057	0.241	

Analyses conducted by U.S.P.H.S., Robert A. Taft Engineering Center, Cincinnati, Ohio on Grab Samples collected by the Redstone Utilities Division.

* Based on Water Consumption During Sept. 1965.

TABLE VII

DDT, DDD AND DDE

CONCENTRATIONS IN BOTTOM MUD SAMPLES

SAMPLE STATION	DATE 1965	DDT ug/kg	DDD ug/kg	DDE ug/kg
WU	9-14	209,840.000	51,282.000	32,100.000
WM	9-15	2,408,755.000	57,692.280	189,000.000
WL	9-14	2,326,640.000	107,500,000	180,000.000
H 4.7	9-14	605,839.000	1,847,058.000	384,000.000
H 2.55	9-14	14,705.900	14,615.400	3,124.400
I 4.6	9-14	9,264.700	2,115.400	1,253.700

Analyses were conducted by the U.S.P.H.S., Robert A. Taft Engineering Center, Cincinnati, Ohio on samples collected by the Redstone Utilities Division.

TABLE VIII

REDSTONE SEWAGE TREATMENT PLANT

SAMPLE DATA

PLANT NO. 1	DATE 1965	TIME CST	TEMP °C	pH	SUS SOL PPM	D.O. PPM	B.O.D. PPM	FLOW GPD
325,000 GPD								
Influent	8-18	0830	26	7.1	4.0		45.0	
	9-2	0900	25	7.0	1.6	2.4	18.5	
	9-3	0915	24	7.1	2.0	2.4	25.0	
Prim. Tank EFF	8-18	0930	26		0.2		24.9	
	9-2	1000	25	7.1	0.1		10.0	
	9-3	1015	24	7.1	0.1		15.1	
Plant EFF	8-18	1030	26		0.0		4.9	500,000
	9-2	1100	25	7.1	0.1	6.9	2.3	280,000
	9-3	1115	24	7.1	0.0	7.0	3.3	140,000
Plant Efficiency B.O.D. Removal	8-18		89%					
	9-2		87.6%					
	9-3		87.0%					

TABLE VIII - Cont'd

REDSTONE SEWAGE TREATMENT PLANT

SAMPLE DATA

PLANT NO. 3	DATE 1965	TIME CST	TEMP °C	pH	SUS SOL PPM	D.O. PPM	B.O.D. PPM	FLOW GPD
600,000 GPD								
Influent	8-18	0830	30	7.4	7.0	0.2	133.9	
	9-2	1030	30	7.2	10.0	0.0	115.8	
	9-3	1030	31	7.2	5.5	0.4	118.8	
Prim Tank EFF	8-18	0930	30	7.3	0.1		85.7	
	9-2	1130	30	7.3	0.1		70.8	
	9-3	1130	29	7.2	0.1		63.7	
Plant EFF	8-18	1430	28	7.2	0.1		26.0	2,000,000
	9-2	1230	28	7.3	0.0	0.5	20.5	1,775,000
	9-3	1230	28		0.1	1.5	16.9	1,775,000
Plant Efficiency	8-18		80.7%					
B.O.D. Removal	9-2		82.3%					
	9-3		85.8%					

TABLE VIII - Cont'd

REDSTONE SEWAGE TREATMENT PLANT

SAMPLE DATA

PLANT NO. 4	DATE 1965	TIME CST	TEMP °C	pH	SUS SOL PPM	D.O. PPM	B.O.D. PPM	FLOW GPD
813,000 GPD								
Influent	8-18	0800	30	6.7	5.0	0.0	183.0	
	9-2	0800		7.0	16.0	0.8	148.8	
	9-3	0800		7.0	3.5	0.7	168.1	
Prim Tank EFF	8-18	0900	30		1.7		130	
	9-2	0900		7.0	0.4		81.3	
	9-3	0900		7.1	0.1		104.0	
Plant EFF	8-18	1000	30	6.7	0.1	2.0	18.6	650,000
	9-2	1000		7.2	0.1	2.6	11.7	700,000
	9-3	1000		7.1	0.1	1.2	11.9	650,000
Plant Efficiency B.O.D. Removal	8-18	90.2%						
	9-2	92.3%						
	9-3	93.0%						

TABLE IX

STREAM FLOWS

	DATE 1965	FLOW MGD
City of Huntsville Waste Treatment Plant [1]	9-8	16
	9-9	19
	9-10	18
Huntsville Spring Branch at Patton Road [2]	9-8	32
	9-9	31
	9-10	31
	11-15	27
	11-16	27
	11-17	27

1 Measurement by Plant Flow Meter.

2 Flow Estimated by using Staff Gauge Reading and Velocity Measurement.

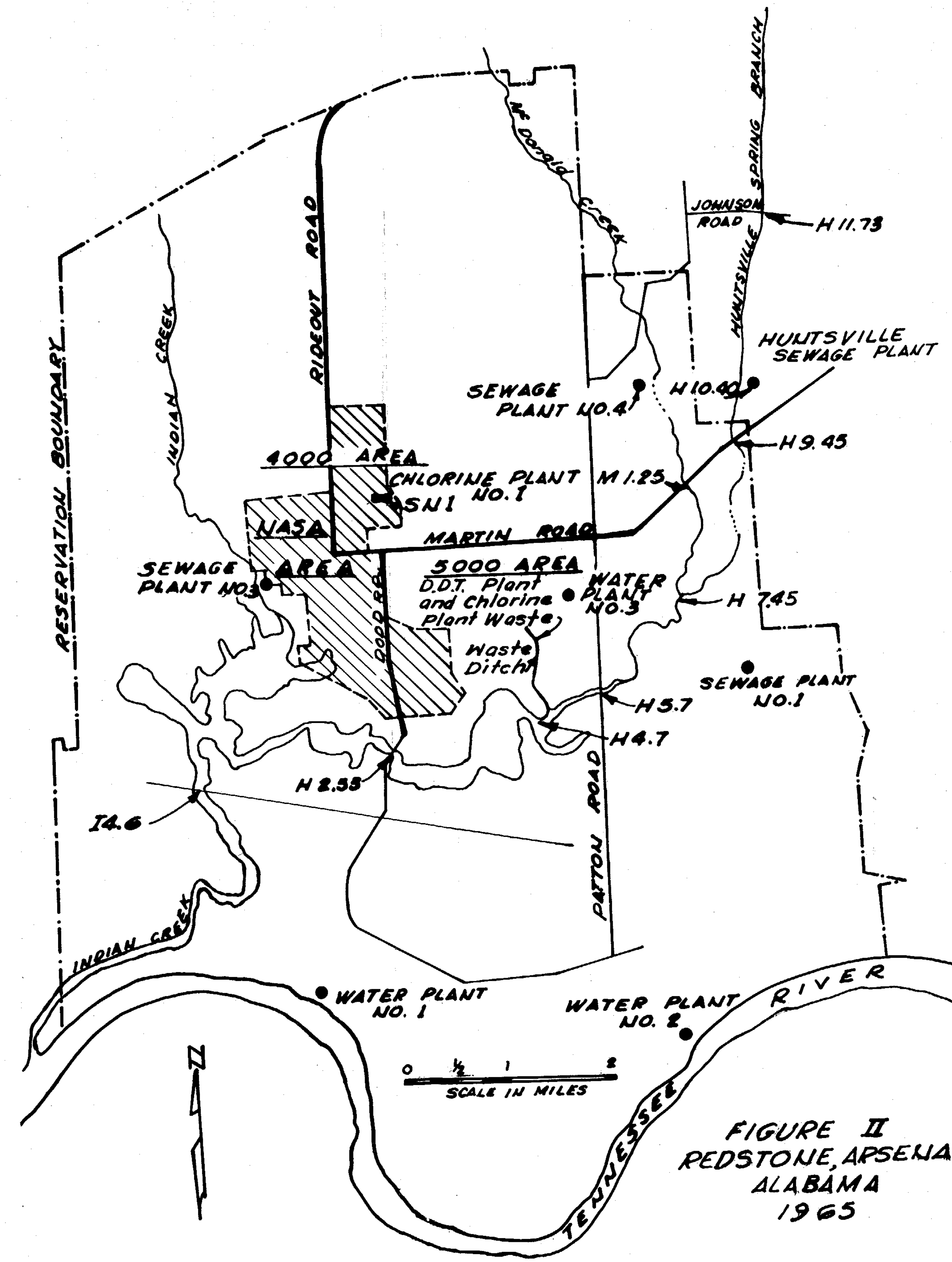

FIGURE II
REDSTONE, ARSENAL
ALABAMA
1965

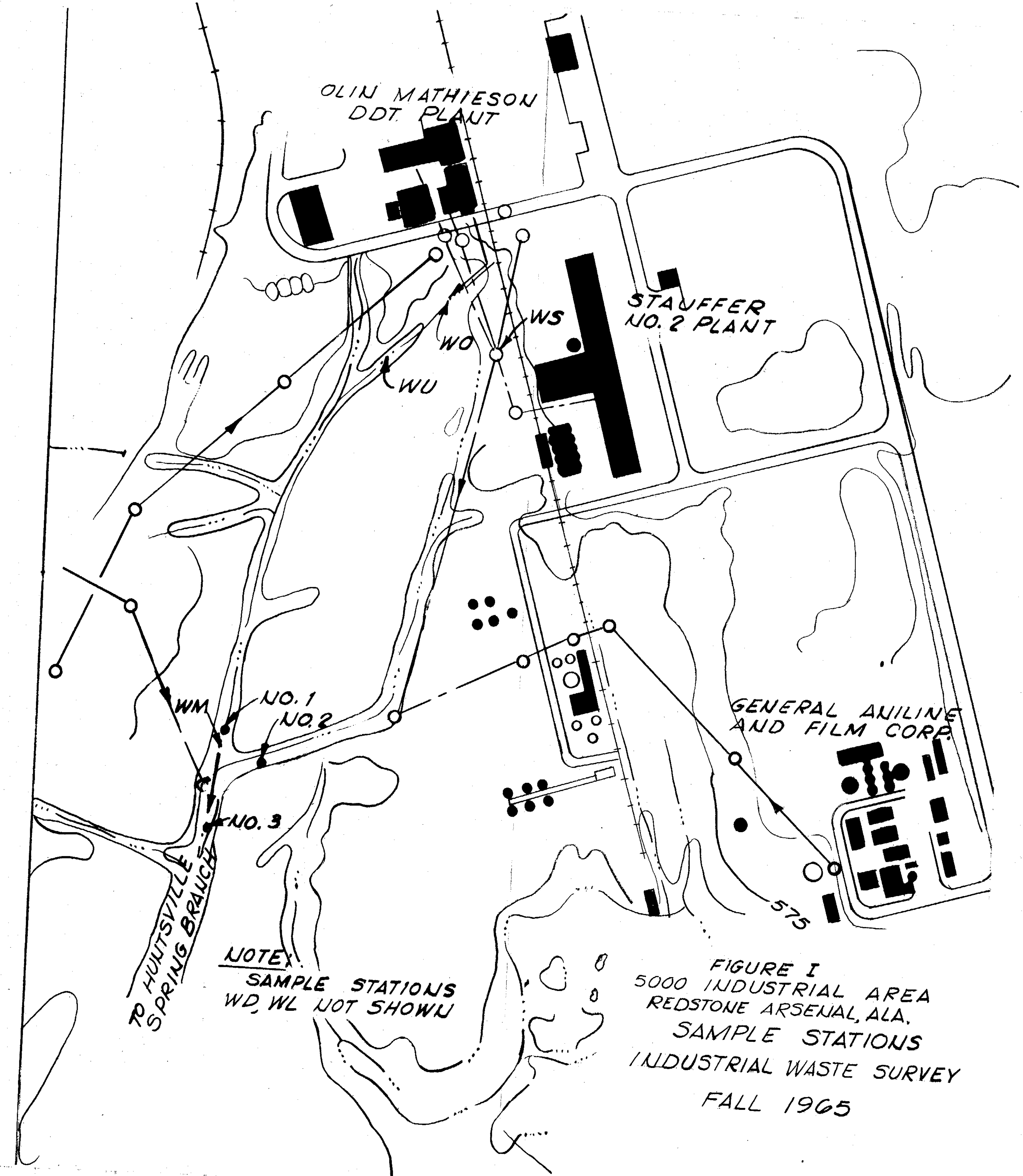

FIGURE I
5000 INDUSTRIAL AREA
REDSTONE ARSENAL, ALA.
SAMPLE STATIONS
INDUSTRIAL WASTE SURVEY
FALL 1965